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Thesis

A STUDY OF THE REACTION OF PUPILS TO A GENERAL SCIENCE CURRICULUM

Submitted by

Clifford R. Nelson

(B.S. in Ed., Boston University, 1933)

In partial fulfillment of requirements for the degree of Master of Education

1948

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CHAPTER I

THE PROBLEM AND METHODS USED TO ASSIST IN ITS SOLUTION

The Nature of the Problem

Junior-high-school general-science courses in need of study and revision.-- The present tendency in education is to fit the educational program to the needs of the individuals concerned so that they may be better fitted through personal experiences to make their particular contribution to society. The general-science offering of the junior high school must fit into this educational program in the most effective way. The problem thus resolves itself to this: "How can the general-science curriculum of the junior high school make its best contribution to the total education of the learner?" The foremost purpose of this paper is to determine the viewpoints of pupils and adults relative to the general-science program as it now is in the writer's school so that the curriculum may be better adapted to the youth of the school. Any school program should be regularly evaluated so that it may be made more effective in helping young people to have experiences which will aid them in reaching the fundamental objective: successful participation in an improving

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democracy. Such evaluation may be made by several methods, one of which is to ask people who are or have been affected by the program to help. The writer plans to use this method and will gather data from pupils who have not studied general science, from those who are now studying it, and from those who have studied it for the three junior-high-school years as well as from the parents of the present pupils of the writer's school.

Collection of information.-- It is the intention of this writer to base his conclusions and interpretations on the data obtained by the use of questionnaires, check lists, and suggestion forms. Boys and girls beginning seventh-grade science, boys and girls who have had seventh-grade science and those who are now studying the eighth- and ninth-grade science courses will be asked to fill out a check list. A representative group of high-school sophomores will be given an opportunity to fill out a four-part questionnaire. The statements of parents will be solicited by means of a letter. Copies of these several forms appear in the Appendix, page 46.

Pupil testimony may not be reliable.-- Fitzpatrick[1] has pointed out that pupil testimony is not reliable enough

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> Interest courses based upon uncritical acceptance of group testimony may not be interest courses at all; certainly we cannot regard them as specifics which are guaranteed to cure all the ills to which the educational process has fallen heir.
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> Taken as a whole, the bulk of pupil (student) testimony gave evidence of being unstable, inconsistent, and unreliable. About 30 to 40 percent of the testimony appeared to be reasonably consistent and reliable ....Nevertheless, the results do tend to cast a shadow of doubt upon the supposed reliability of many pupil responses that have been regarded as evidences of pupil interest.

Science textbooks alone not enough.-- Many science courses are taught from the textbooks alone. Such courses cannot meet the obligation of meeting the needs of the pupils. Leonelli[1] has pointed out that the science textbooks do not contain all that is needed to meet the requirements of the newer curriculum. In his paper he makes the following statements:

> Upon the examination of the subject-matter content (of several science books) it was readily seen that there was little or no agreement among the authors of different textbooks as to the subject matter to be taught the students of general science.

Better teacher training needed as well as better instructional materials.-- A partial solution to the problem may be obtained through a better program of training

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> Thus general science is meeting the demand for an elementary science which will serve as a prerequisite course for the more advanced sciences. Fortunately, the teachers of this science have well organized texts on the multiple lists. It must not be supposed that just any teacher who has a little of some science is capable of teaching general science to a group of wide-awake American boys and girls. A teacher who has the technique of teaching and knows the sciences of everyday life, is probably better prepared to teach the course than someone who has had special training in only one of the sciences.
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> The course in general science should be complete in itself and as a "unit course" be looked upon as independent of later courses in science. General science is not a series of short and independent courses in physics, chemistry, biology, physiography, and other sciences. Only as these sciences contribute to a unified course of instruction in the practical problems of the pupil's life should they be considered. For many students this is the only science they will get. For this reason it should have to do with the life conditions affecting the pupils, and its subject matter should be largely selected from their environment. It will therefore, vary greatly in different communities.

Others agree that the teacher is the key in solving the teaching and learning problems.-- The Texas Department of Education is not alone in advocating not only better training and teaching materials for teachers but in placing teachers in positions for which they are trained and adapted.

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Frolio,[1] for example, indicates that the successful solution of the curriculum problem requires teachers suited to the situation.

> In answer to the question "what do you consider to be the objection which would have to be overcome in order that General Science may be acceptable and incorporated in the curriculum of the seventh and eighth and ninth grade in all junior high schools?" all seem to agree that well trained teachers who understand the subject matter from the pupil's point of view and suitable equipment must be had.

Science curriculum does not serve the needs of pupils.--Several studies have shown that traditional curricula do not serve the best interests and needs of the boys and girls of our schools. One study that indicates this is that made by Kane[2] who includes the following statements in his conclusions:

> Both sexes saw little use of astronomy except the highest third boys.
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> Elements lacked usefulness appeal to all except highest ability groups.
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> In spite of the novelty attached to its use, class work with the microscope was uninteresting and useless to lowest ability groups.
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> Alcohol and tobacco, as well as propaganda efforts were rated as useful and interesting even in lowest ability groups.

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Present curriculum needs critical study.-- The problem of curriculum planning is not a simple one. It is a problem which requires careful and critical analysis of the present curriculum in terms of both the content and the methods used. Heiss, Osbourn, and Hoffman[1] give us some material to think critically about when evaluating present curricula.

> In the final analysis a point of view as philosophy in any field is a personal thing molded and shaped by individual experiences and backgrounds.
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> The young people whom we teach are experiencing life on every hand and must be conditioned to adjust to its forces and to solve the problems which are at their maturity levels....The science teachers are faced with the necessity of becoming sensitive to these problems of boys and girls and so setting the stage for learning that science materials will make a contribution in the solution of their problems.
>
> A study of the aspects of present-day living which seem to have science antecedents or implications and a study of the needs of boys and girls as considered by their behavior pattern would seem to reveal that there are many focal points where science can aid in the adjustment of the individual.
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> Suggested classifications of the functions of science in the adjustment of individuals.
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> 1. Science can contribute a fund of interpretive understandings to aid in the adjustment of individuals.
> 2. Science can contribute a fund of appreciations to aid in the adjustment of individuals.
> 3. Science can contribute a group of attitudes or mind-sets to aid in the adjustment of individuals.

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Elmood D. Hess, Ellsworth S. Woburn, and C. Wesley Hoffman, Modern Methods and Materials for Teaching Science. Macmillan Company, Boston, 1960, pp. 6, 7, 11, 12.

4. Science can contribute a method of attack on problems to aid in the adjustment of individuals.

....when interpretive generalizations are the outcomes sought, the needs of a larger group of students will be met.

The writers of the above-mentioned book also quote the following from Pieper.[1]

A useful list of criteria to be used in the selection of adjustments for junior high school.

When in each case all other things are considered equal, criteria should be applied that will assure that those adjustments selected are:--

1. Universal in their application to life needs.
2. In accord with the findings of science.
3. In harmony with the best interests of society.
4. Crucial in individual or social life.
5. Conducive to the desire to make further worthwhile adjustments.
6. Of the proper order of difficulty.
7. Highly satisfactory to the individual without harm to others or himself.
8. Desired by pupils.
9. Identifiable in their attainment.
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Scientific literacy is essential today.-- Sinnott[1] has much to say about the importance of science knowledge and its methods in its relation to the kind of world we live in.

> This is the day of natural science. Certainly to face the problems of the modern world, citizens in a democracy must know more about natural science than most of them do now--not only more facts about it but more about its methods, possibilities, and limitations. On the other hand, natural science has placed in the hands of man such tremendous power that unless he learns to master it wisely it will master him. He must know much about man and his past, about the time-tested values which make civilization possible.
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> There is no room for scientific illiteracy in modern society....
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> But the other side of our problem is equally important. The student of natural science must have an appreciation of those wide fields of human knowledge which lie outside his subject--literature, the arts, philosophy....

The Community

Community a suburban area.-- The community with which this investigation deals is a residential suburban city of about 80,000 people. Although it contains some industrial projects, it is primarily a residential community in which office workers of a nearby large city live as well as businessmen and professional workers. It is a progressive city and is well known for its interest in community activities and enterprises, its government, and its schools. A study

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of its school population would show that a smaller percentage of pupils come from families of low income than in most other cities.

The General-Science Program in the Junior High School

Time allotment for science in the junior high school.-- The time allotted in the junior high school with which the writer is concerned, varies with each grade. In the seventh grade general-science classes are held for four, forty-two minute periods a week for one-half year. In the eighth grade, classes meet twice a week for the same length period for the entire year. In the eighth-grade classes the same teacher has the same group for both science and mathematics. This is an experiment to determine the extent to which general science and mathematics can be correlated and also to reduce the number of individuals that the teacher need meet. In the ninth grade the divisions meet four times a week for forty-two minute periods. They meet for the entire year. General science is a required course in each grade.

Content of the general-science courses.-- The content of the general-science courses of the writer's school is typical of the usual junior high school. In grade seven some time is spent on a general introduction to science. This is followed by a series of units which cover such

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topics as plants, animals, air, water, food, and nutrition. In grade eight there are units on astronomy, living things, food, health, and some elementary concepts in the field of chemistry. Grade nine continues with elementary introductions to the science of fire, chemical and physical change, magnetism and electricity, communications and power generation as in various kinds of motors and engines.

Methods Used to Gather Evidence to Assist in Solving the Problem

Pupils may assist.-- Education should be so designed that it will meet the needs of all youth; therefore, one logical place to go to gather evidence of the needs of youth is to youth itself. Junior-high-school education in the city under discussion covers the public school grades of seven, eight, and nine. During these three years children may change a great deal. With this thought in mind it was decided to poll the opinions of beginning seventh-graders in order to determine what things they would like to study in seventh-grade general science. A questionnaire was constructed (see Appendix, pages 46-47) listing twenty-five topics which were obtained from an investigation of several junior-high-school general-science textbooks. This list of books appears in the Appendix on page 52. Explanatory notes were included because the science experiences of the pupils

were limited. The pupils were requested to indicate which topical areas they thought they might like to study. Some of the pupils had studied a little science in the elementary schools. Therefore, Part II of the questionnaire was included in order to give the pupil an opportunity to indicate his like or dislike for science as he knew it.

The high-school sophomore is asked to assist.-- Another logical source of information relative to the problem was the high-school sophomore. This pupil had finished his junior-high-school experiences and was therefore in a position to look back over his general-science schooling and state his opinions about it. Another questionnaire was constructed (see Appendix, pages 49-50) and submitted to a mixed group of high-school sophomores. This questionnaire sought four specific kinds of information: first, a list of the three most interesting phases of junior-high-school science; secondly, the three areas of general science which had proved most difficult to understand; thirdly, the three areas which the pupil would classify as having been most helpful or useful to him. Lastly he was asked to indicate three additional areas he would like to have been given the opportunity to study but had not.

The adult was asked to help.-- Today's pupils are tomorrow's adults. If this be so, then today's adults should be able to offer some help in solving the problem by giving

their suggestions, in terms of their own experiences, regarding the content of the school curricula. It was decided to solicit the help of parents by asking them to suggest areas of study which might have been helpful to them and/or which they felt might prove helpful to their children. A letter was composed (see Appendix, page 51) and sent to approximately one hundred and forty homes asking for the viewpoint and suggestions of the mother and of the father.

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CHAPTER II

TABULATIONS AND INTERPRETATIONS OF RESULTS

Interests of pupils vary in degree.-- The total behavior pattern of an individual is a complex composite of a number of basic patterns. No two people are exactly alike in any one of them. This is an important fact to keep in mind when dealing with a group of school children. It poses a number of problems for the teacher as well as the reviser of the curriculum.

When we consider the individual's interests we are dealing with one of the basic patterns which color his behavior. A study of the results obtained from the questionnaire presented to seventh-, eiththh-, and ninth-grade pupils makes this variation in interest, at least for these groups, quite evident. These results are presented in Table I on pages 14 and 15.

It is evident that the list of topics which comprise this table represent the science textbook units with which we are all familiar. They were used in order to insure that the interest factor could be determined on the basis of what they had studied in their general-science courses. The results show that there is considerable variation in the

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Table I. Science Topics, Placed in Descending Order of Interest, as Indicated by Pupils of Seventh, Eighth, and Ninth Grades.

Topic with Explanatory Words Used in Questionnaire	Interest Placement	Number of Pupils
(1)	(2)	(3)
Communications, telephone, radio, radar, television.....	1	126
Medicine, drugs, disease, germs, bacteria.....	1	126
Chemistry, acids, soaps, paints.	2	120
Astronomy, sun, stars, planets, shooting stars, telescopes....	3	108
Early animals, fossils, dinosaurs.....	4	107
Animals, birds, fish, mammals, insects.....	5	105
Human body and health, sleep, structure, foods.....	6	103
Electricity, motors, bells, lights, wiring.....	7	92
Airplanes, how and why they fly.	8	85
Engines, steam, gasoline, diesel, jet rocket.....	9	83
Sound, noises, musical instruments, voice.....	10	80
Light, causes, kinds, color, dyes, uses.....	11	78
Molecules and atoms, what everything is made of.....	12	74
Weather, causes, forecasting, flying, kinds.....	13	71
Earth science, rocks, soil, minerals.....	14	70
Transportation, science of autos, trains, ships.....	15	66
Fire, what it is, how man uses it.....	16	61
Biography, great scientists of past and present.....	17	60
Machines, wheels, pulleys, crowbars, wheelbarrows.....	18	52
Atmosphere, where air is found, how man uses it.....	19	49

Table I. Science Topics, Placed in Descending Order of Interest, as Indicated by Pupils of Seventh, Eighth, and Ninth Grades.

Topic with Explanatory Words Used in Questionnaire	Interest Placement	Number of Pupils
(1)	(2)	(3)
Communications, telephone, radio, radar, television.....	1	126
Medicine, drugs, disease, germs, bacteria.....	1	126
Chemistry, acids, soaps, paints.	2	120
Astronomy, sun, stars, planets, shooting stars, telescopes....	3	108
Early animals, fossils, dinosaurs.....	4	107
Animals, birds, fish, mammals, insects.....	5	105
Human body and health, sleep, structure, foods.....	6	103
Electricity, motors, bells, lights, wiring.....	7	95
Airplanes, how and why they fly.	8	85
Engines, steam, gasoline, diesel, jet rocket.....	9	83
Sound, noise, musical instruments, voice.....	10	80
Light, causes, kinds, color, dyes, uses.....	11	78
Molecules and atoms, what everything is made of.....	12	74
Weather, causes, forecasting. flying, kinds.....	13	71
Earth science, rocks, soil, minerals.....	14	70
Transportation, science of autos, trains, ships.....	15	66
Fire, what it is, how man uses it.....	16	61
Biography, great scientists of past and present.....	17	60
Machines, wheels, pulleys, screws, bars, wheelbarrows.....	18	52
Atmosphere, where air is found, how man uses it.....	19	49

Table I. (concluded)

Topic with Explanatory Words Used in Questionnaire	Interest Placement	Number of Pupils
(1)	(2)	(3)
Changing substances, by heating, cooling, mixing.....	20	47
Water, what it is, how man uses it.....	21	46
Conservation, fire prevention, forests, rivers, soil.....	21	46
Science, how the scientist does his work.....	22	44
Plants, including trees, flowers, leaves.....	23	32

indicated interests of the boys and girls. Two significant things are shown in this table. First, all topics are of some interest to some people, and secondly, that some topics are of great interest to large groups of students. For example, we find that 23 boys and girls show an interest in plants while 126 show an interest in communications. To the teacher of general science the implication might be to limit the scope of the science program to those topics and activities which seem to have interest for the greater number. It might also imply that the general-science program should be so constructed that it gives opportunities to all the pupils to satisfy the needs they have in terms of their immediate interests.

Children are interested in many things and a number of these interests can be cultivated through their general-

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Children are interested in many things and a number of these interests can be cultivated through their general-

science classes. This fact may naturally lead to the conclusion that their interests are pretty well taken care of by the available textbooks in general science. However, the writer raises the question of whether the textbooks tend to determine the interests of the pupils to the limitations imposed by the textbook content. Also, it must be noted here, the questionnaire was of the clue type and therefore a leading one. Thus, the determinations of this questionnaire are limited to the topics included.

With this in mind it was decided to give pupils, who have had the full three-year offering of the junior-high-school general science, an opportunity to indicate the areas which they thought most interesting without giving them any leading clues whatever.

High-school sophomores furnish different evidence.--This questionnaire was presented to a group of 140 high-school sophomores. The tabulation of the results of Section I of this questionnaire are shown in Table II on page 17.

The results shown here are quite different from those obtained from the survey of the seventh-, eighth-, and ninth-graders by means of the clue-furnished questionnaire. The greatest degree of interest is now in the general area of electricity. However, only 44 out of the group of 140 so place it. Where a study of medicine, including drugs, disease, germs and bacteria evoked a response of interest

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Table II. General-Science Topics Listed in Alphabetical Order, Which Were Indicated by High School Sophomores as of Interest to Them.

Topic	Section I A			Section I B			Section I C		
	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Animals...	3	0	3	2	4	6	6	2	8
Astronomy.	0	1	1	0	0	0	0	0	0
Atmosphere	0	0	0	0	0	0	0	0	0
Aviation..	0	1	1	0	1	1	0	0	0
Bacteria..	6	2	8	0	1	1	2	2	4
Biology...	0	0	0	0	0	0	2	2	4
Chemistry.	1	3	4	2	6	8	1	0	1
Disease...	12	4	16	6	4	10	6	3	9
Electricity	7	37	44	4	12	16	6	6	12
General discussion	0	0	0	0	0	0	0	1	1
Great scientists	0	0	0	0	0	0	0	0	0
Heat.....	1	1	2	1	0	1	3	3	6
Human body	9	3	12	14	2	16	1	7	8
Light.....	0	0	0	1	0	1	1	2	3
Machines..	1	0	1	1	2	3	0	0	0
Magnetism.	0	0	0	1	0	1	0	0	0
Matter and energy...	1	0	1	0	3	3	0	4	4
Nutrition.	3	0	3	6	0	6	7	6	13
Plants....	7	3	10	6	4	10	5	2	7
Sound.....	0	2	2	0	1	1	1	1	2
Weather...	10	10	20	15	22	37	7	7	14
Water supply...	0	0	0	0	0	0	0	1	1

from 126 (see Table I), only a total of 24 showed an interest in the corresponding group (bacteria and disease combined, Table II). To emphasize by a third example, a comparison of the two related topics, molecules and atoms in Table I and energy and matter in Table II, shows that 74 showed an

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	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Animals...	3	0	3	2	4	6	6	2	8
Astronomy.	0	1	1	0	0	0	0	0	0
Atmosphere	0	0	0	0	0	0	0	0	0
Aviation..	0	1	1	0	1	1	0	0	0
Bacteria..	6	2	8	0	1	1	2	2	4
Biology...	0	0	0	0	0	0	2	2	4
Chemistry.	1	3	4	2	6	8	1	0	1
Disease...	12	4	16	6	4	10	6	3	9
Electricity	7	37	44	4	12	16	6	6	12
General dissociation theat	0	0	0	0	0	0	0	1	1
solenlata	0	0	0	0	0	0	0	0	0
Heat.....	1	1	2	1	0	1	3	3	6
Human body	9	3	12	14	2	16	1	7	8
Light.....	0	0	0	1	0	1	1	2	3
Machines..	1	0	1	1	2	3	0	0	0
Magnetism.	0	0	0	1	0	1	0	0	0
Matter and energy...	1	0	1	0	3	3	0	4	4
Nutrition.	3	0	3	6	0	6	7	6	13
Plants....	7	3	10	6	4	10	5	2	7
Sound.....	0	2	2	0	1	1	1	1	2
Weather...	10	10	20	15	22	37	7	7	14
Water supply...	0	0	0	0	0	0	0	1	1

From 126 (see Table I), only a total of 24 showed an interest in the corresponding group (bacteria and disease combined, Table II). To emphasize by a third example, a comparison of the two related topics, molecules and atoms in Table I and energy and matter in Table II, shows that 74 showed an

interest in the former but only one so indicated in the latter.

The writer recognizes that the above comparisons do not give the total picture, but, nevertheless, there is enough of an indication of a truth to warrant further study of the situation. Also one may accept it to the extent that the following generalization may be drawn. It is not sufficient for the teacher of a general-science course to merely follow the textbook if he cares to deal with the real interests of boys and girls.

All boys and girls do not like general science.-- Another indication of the interest boys and girls have in the study of general science is shown by the data of Table III on page 19. The figures for this table were obtained by asking boys and girls of grades seven, eight, and nine to answer frankly the question relating to their like or dislike of general science. The results are significant to the teacher of general science in the writer's school. They are particularly significant in providing a sufficient and good reason for considering the need for change in science time allotment and subject matter or content.

In this table we find that, of a total of 227 boys and girls, 174 said that they liked to study general science while 50 said that they did not. Seven of them turned in blanks to the question. To put it differently, 3.54 pupils

Table III. Results Obtained to Part II of the Questionnaire from Grades Seven, Eight, and Nine in Which the Pupils Were Asked to State Whether They Do or Do Not Like to Study General Science.[1]

Grade	Do Like Science	Do Not Like Science	Blank	Totals
(1)	(2)	(3)	(4)	(5)
7	82	9	0	91
8	54	15	2	71
9	38	26	1	65
Totals	174	50	3	227

did like general science for each one who said he did not. However, as we look into the facts more closely, we see some rather significant data related to the grades represented. In grade seven, for example, we find the ratio is 9.1 to 1 in favor of those who like science. In grade eight the ratio decreases to 3.6 who like science to each one who does not. In grade nine, however, we find the startlingly low ratio of only 1.46 people who like science to each one who does not. This descending rate of interest in science is and should be of considerable concern as well as interest to the person who tries to provide the science experiences for our boys and girls. The writer elaborates on the significance of this table in the chapter on conclusions and

[1] See copy of questionnaire in Appendix, pages 46-47.

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Grade	Do Like Science	Do Not Like Science	Blank	Totals
(1)	(2)	(3)	(4)	(5)
7	82	9	0	91
8	84	15	2	71
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[1] See copy of questionnaire in Appendix, pages 45-47.

recommendations.

Most difficult areas not always least interesting.--The difficulty of a job or an assignment can determine to a large extent one's interest in it as well as the ease with which it may be done. Granted that there are many routine tasks that all people, regardless of vocation, must do, nonetheless it is likewise true that difficult jobs are sometimes the most interesting to do. To determine if any significant facts could be obtained relative to this view, a section of the questionnaire was addressed to the sophomores asking them to list the three topics with which they had the most difficulty. The results of this section have been shown on page 21 in Table IV.

We note that the topic, electricity, is the one which was mentioned most often as being of difficulty to the greatest number of students. Actually 69 out of a group of 147 called it a difficult topic. This, in percentage, means that 46.8 percent found the work on the topic electricity difficult. At the same time a reference to Table II, page 17, shows that 72 out of the group of 140, or a percentage of 51.4, found the topic interesting.

At the other extreme we find that interest in the topic, weather, is indicated by 71 of the 140 or 50.6 percent, while it was difficult to only 24.4 percent.

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At the other extreme we find that interest in the topic, weather, is indicated by 71 of the 140 or 50.6 percent, while it was difficult to only 24.4 percent.

Table IV. Science Topics, Listed in Alphabetical Order, Which Were Indicated by High-School Sophomores as Being Difficult.

Topic	Section II A			Section II B			Section II C		
	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Animals....	0	0	0	0	2	2	0	0	0
Astronomy..	2	4	6	4	3	7	2	1	3
Atmosphere.	2	0	2	1	0	1	1	0	1
Aviation...	0	0	0	0	0	0	0	0	0
Bacteria...	1	0	1	0	0	0	1	0	1
Biology....	0	1	1	0	0	0	0	1	1
Chemistry..	1	2	3	1	0	1	1	2	3
Disease....	0	3	3	0	1	1	1	1	2
Electricity	46	10	56	5	7	12	1	0	1
General discussion	0	0	0	0	0	0	0	0	0
Great scientists	0	0	0	1	1	2	0	1	1
Heat.....	1	1	2	1	3	4	0	2	2
Human body.	1	2	3	0	2	2	1	1	2
Light.....	0	0	0	0	0	0	2	0	2
Machines...	1	0	1	4	0	4	1	0	1
Magnetism..	0	0	0	1	0	1	0	0	0
Matter-energy....	0	2	2	4	0	4	1	5	6
Nutrition..	0	4	4	3	5	8	4	2	6
Plants.....	0	4	4	3	5	8	4	2	6
Sound.....	0	0	0	1	0	1	0	1	1
Water supply....	0	0	0	0	0	0	0	0	0
Weather....	7	8	15	11	4	15	5	1	6

From these comparisons it is apparent that a topic should not be excluded from the general-science course merely because it is difficult. It would seem that other methods to be used in teaching the subject should be sought in order to capitalize on the pupil interest which is apparently there.

Table IV. Science Topics, Listed in Alphabetical Order, Which Were Indicated by High-School Sophomores as Being Difficult.

Topic	Section II A			Section II B			Section II C		
	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Animals	0	0	0	0	2	2	0	0	0
Astronomy	2	4	6	4	3	7	2	1	3
Atmosphere	2	0	2	1	0	1	1	0	1
Aviation	0	0	0	0	0	0	0	0	0
Bacteria	1	0	1	0	0	0	1	0	1
Biology	0	1	1	0	0	0	0	1	1
Chemistry	1	2	3	1	0	1	1	2	3
Diseases	0	3	3	0	1	1	1	1	2
Electricity	46	10	56	5	7	12	1	0	1
General dissociation	0	0	0	0	0	0	0	0	0
Great scientists	0	0	0	1	1	2	0	1	1
Heat	1	1	2	1	3	4	0	2	2
Human body	1	2	3	0	2	2	1	1	2
Light	0	0	0	0	0	0	2	0	2
Machines	1	0	1	4	0	4	1	0	1
Magnetism	0	0	0	1	0	1	0	0	0
Matter-energy	0	2	2	4	0	4	1	5	6
Nutrition	0	4	4	3	2	5	4	2	6
Plants	0	4	4	3	2	5	4	2	6
Sound	0	0	0	1	0	1	0	1	1
Water supply	0	0	0	0	0	0	0	0	0
Weather	7	8	15	11	4	15	5	1	6

From these comparisons it is apparent that a topic should not be excluded from the general-science course merely because it is difficult. It would seem that other methods to be used in teaching the subject should be sought in order to capitalize on the pupil interest which is apparently there.

We should try to make topics studied functional.-- That which is worth teaching should be useful to the learner. The sooner the individual can make use of that which he has learned, the more valuable that learning becomes. Another problem concerning the curriculum is posed here. Who shall determine what is or is not useful to the learner? Should the adult determine it because of his many and varied experiences? Shall the learner at the junior-high-school level determine it because he is to acquire it? The answer is probably not known in all its complications but it will probably consist of an amalgamation of the two viewpoints. The writer wanted to obtain the pupil's viewpoints and opinions concerning those areas which had been studied and found useful. Section III of the questionnaire to sophomores was designed to accomplish this purpose. The results have been tabulated on page 23 in Table V.

It is evident that many of the pupil's experiences did not register as being particularly useful, at least up to the time of this questionnaire. Those topics which were recorded as useful by a significant number of pupils were electricity, weather, plants, and disease.

It would be interesting to ask these boys and girls the same question at a somewhat later date. Perhaps the data obtained then would show that some of the topics studied had long-range values. On the other hand, perhaps we should try

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Table V. Science Topics, Listed in Alphabetical Order, Which Were Indicated by High-School Sophomores as Being Useful to Them.

Topic	Section III A			Section III B			Section III C		
	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Animals...	0	0	0	0	0	0	1	0	1
Astronomy.	1	1	2	1	0	1	0	0	0
Atmosphere	0	0	0	0	0	0	0	0	0
Aviation..	0	1	1	0	0	0	0	0	0
Bacteria..	2	2	4	1	0	1	0	2	2
Biology...	0	1	1	0	1	1	0	0	0
Chemistry.	0	2	2	0	1	1	1	0	1
Disease...	9	4	13	4	0	4	4	2	6
Electricity	1	24	25	3	10	13	1	3	4
General discussion	0	1	1	0	0	0	0	0	0
Great scientists	0	0	0	0	0	0	0	0	0
Heat.....	1	1	2	1	1	2	0	3	3
Human body	8	3	11	2	3	5	1	2	3
Light.....	0	0	0	0	0	0	0	1	1
Machines..	0	0	0	0	1	1	0	0	0
Matter-energy...	0	0	0	0	2	2	0	2	2
Molecular theory...	0	0	0	0	0	0	0	0	0
Nutrition.	5	0	5	2	2	4	4	0	4
Plants....	6	4	10	7	5	12	3	2	5
Sound.....	0	0	0	0	0	0	0	0	0
Water supply...	0	0	0	0	0	0	0	0	0
Weather...	10	8	18	5	5	10	2	3	5

to make the areas studied by boys and girls more functional in the present because boys and girls live in the present. Again the teacher as well as the administrator and others concerned with the curriculum face a problem which merits early attention.

Table V. Science Topics, Listed in Alphabetical Order, Which Were Indicated by High-School Sophomores as being Useful to Them.

Topic	Section III A			Section III B			Section III C		
	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Animals...	0	0	0	0	0	0	1	0	1
Astronomy.	1	1	2	1	0	1	0	0	0
Atmosphere	0	0	0	0	0	0	0	0	0
Aviation..	0	1	1	0	0	0	0	0	0
Bacteria..	2	2	4	1	0	1	0	2	2
Biology...	0	1	1	0	1	1	0	0	0
Chemistry.	0	2	2	0	1	1	1	0	1
Diseases...	9	4	13	4	0	4	4	2	6
Electricity	1	24	25	3	10	13	1	3	4
General discussion	0	1	1	0	0	0	0	0	0
Great scientists	0	0	0	0	0	0	0	0	0
Heat.....	1	1	2	1	1	2	0	3	3
Human body	8	3	11	2	3	5	1	2	3
Light.....	0	0	0	0	0	0	0	1	1
Machines..	0	0	0	0	1	1	0	0	0
Matter-energy...	0	0	0	0	2	2	0	2	2
Molecular theory...	0	0	0	0	0	0	0	0	0
Nutrition.	6	0	6	2	2	4	0	4	4
Plants....	6	4	10	7	5	12	3	2	5
Sound.....	0	0	0	0	0	0	0	0	0
Water supply...	0	0	0	0	0	0	0	0	0
Weather...	10	8	18	5	5	10	2	3	5

to make the areas studied by boys and girls more functional in the present because boys and girls live in the present. Again the teacher as well as the administrator and others concerned with the curriculum face a problem which merits early attention.

Things which pupils say they would like to have studied.--In Table VI below we find the results tabulated which were obtained from Section IV of the questionnaire submitted to the sophomore group of students. In this section they were asked to indicate those areas in general science which they

Table VI. Science Topics, Listed in Alphabetical Order, Which Were Indicated by High-School Sophomores as Topics Which They Would Like to Have an Opportunity to Study.

Topic	Section IV A			Section IV B			Section IV C		
	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Animals...	5	5	10	0	2	2	2	0	2
Astronomy.	4	1	5	0	1	1	1	0	1
Atmosphere	1	0	1	2	0	2	0	0	0
Aviation..	0	3	3	0	0	0	0	3	3
Bacteria..	2	1	3	1	0	1	1	1	2
Biology...	3	0	3	1	3	4	1	0	1
Chemistry.	2	4	6	2	2	4	0	0	0
Disease...	4	0	4	0	3	3	1	0	1
Electricity	0	2	2	0	4	4	0	1	1
General discussion	0	0	0	0	0	0	0	0	0
Great scientists	0	0	0	0	0	0	1	0	1
Heat.....	0	1	1	0	0	0	0	0	0
Human body	8	6	14	5	5	10	0	0	0
Light.....	0	1	1	0	0	0	0	1	1
Machines..	0	1	1	0	0	0	0	0	0
Magnetism.	0	0	0	0	0	0	0	0	0
Matter energy...	0	0	0	0	1	1	0	0	0
Molecular theory...	0	0	0	0	0	0	0	0	0
Nutrition.	0	0	0	0	0	0	1	1	2
Plants....	2	1	3	0	1	1	0	1	1
Sound.....	0	1	1	0	0	0	0	0	0
Water supply...	0	0	0	0	0	0	0	0	0
Weather...	0	2	2	0	1	1	0	2	2

Things which pupils say they would like to have studied.--

In Table VI below we find the results tabulated which were obtained from Section IV of the questionnaire submitted to the sophomore group of students. In this section they were asked to indicate those areas in general science which they

Table VI. Science Topics, Listed in Alphabetical Order, Which Were Indicated by High-School Sophomores as Topics Which They Would Like to Have an Opportunity to Study.

Topic	Section IV A			Section IV B			Section IV C		
	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Animals...	5	5	10	0	2	2	2	0	2
Astronomy.	4	1	5	0	1	1	1	0	1
Atmosphere	1	0	1	2	0	2	0	0	0
Aviation..	0	3	3	0	0	0	0	3	3
Bacteria..	2	1	3	1	0	1	1	1	2
Biology...	3	0	3	1	3	4	1	0	1
Chemistry.	3	4	7	2	2	4	0	0	0
Disease...	4	0	4	0	3	3	1	0	1
Electricity	0	2	2	0	4	4	0	1	1
General discussion	0	0	0	0	0	0	0	0	0
Great scientists	0	0	0	0	0	0	1	0	1
Heat.....	0	1	1	0	0	0	0	0	0
Human body	8	6	14	5	5	10	0	0	0
Light.....	0	1	1	0	0	0	0	1	1
Machines..	0	1	1	0	0	0	0	0	0
Magnetism.	0	0	0	0	0	0	0	0	0
Matter and energy...	0	0	0	0	1	1	0	0	0
Molecular theory...	0	0	0	0	0	0	0	0	0
Nutrition.	0	0	0	0	0	0	1	1	2
Plants....	2	1	3	0	1	1	0	1	1
Sound.....	0	1	1	0	0	0	0	0	0
Water supply...	0	0	0	0	0	0	0	0	0
Weather...	0	2	2	0	1	1	0	2	2

would have enjoyed studying if they had been given the opportunity. Instead of including the statements as they were given by the students, the writer classified them and placed them in the categories which were used in the table. They are the same as the topics in the other tables. For example: a student may have written, "I would like to have studied the causes of disease." This falls into the classification or topic, bacteria.

One may draw two significant conclusions from these data. One conclusion is that pupils who indicated certain specific areas had had previous experiences in them. Perhaps they intended to indicate that they would like to study them in greater detail. This, in turn, may indicate that the experiences they did have were not real and meaningful enough so that they remembered them. The second conclusion which may be drawn is that they had little or nothing to offer in addition to what is now being offered in general-science courses as currently provided. In any event, nothing of outstanding usefulness, except as mentioned above, was offered which would aid in the reorganization of the science curriculum.

A composite tabulation of the four sections of this questionnaire presented to sophomores is given in Table VII on page 26. This table is in a sense supplementary to the table shown as Table VIII on page 27. Table VII includes

would have enjoyed studying if they had been given the opportunity. Instead of including the statements as they were given by the students, the writer classified them and placed them in the categories which were used in the table. They are the same as the topics in the other tables. For example: a student may have written, "I would like to have studied the causes of disease." This falls into the classification or topic, bacteria.

One may draw two significant conclusions from these data. One conclusion is that pupils who indicated certain specific areas had had previous experiences in them. Perhaps they intended to indicate that they would like to study them in greater detail. This, in turn, may indicate that the experiences they did have were not real and meaningful enough so that they remembered them. The second conclusion which may be drawn is that they had little or nothing to offer in addition to what is now being offered in general science courses as currently provided. In any event, nothing of outstanding usefulness, except as mentioned above, was offered which would aid in the reorganization of the science curriculum.

A composite tabulation of the four sections of this questionnaire presented to sophomores is given in Table VII on page 28. This table is in a sense supplementary to the table shown as Table VIII on page 27. Table VII includes

Table VII. Summary Table Showing the Combined Results of Table II, Table IV, Table V, and Table VI.

Topic	Section I Interest	Section II Difficulty	Section III Usefulness	Section IV Would Like to Study
(1)	(2)	(3)	(4)	(5)
Animals.....	5	2	1	14
Astronomy...	18	16	3	7
Atmosphere..	0	5	0	3
Aviation....	1	0	0	6
Bacteria....	13	2	7	6
Biology.....	4	2	2	8
Chemistry...	13	7	4	10
Disease.....	35	6	23	8
Electricity.	72	69	42	7
General discussion....	1	0	1	1
Geology.....	0	0	0	3
Great scientists.....	0	3	0	1
Heat.....	9	8	7	1
Human body..	36	7	19	24
Light.....	4	2	1	2
Machines....	4	6	0	1
Magnetism...	1	1	1	0
Matter-energy.....	8	12	4	1
Nutrition...	22	18	13	2
Plants.....	27	11	27	5
Psychology..	0	0	0	3
Radio.....	0	0	0	5
Sound.....	5	2	0	1
Water supply	1	0	0	0
Weather.....	71	36	33	5

all the responses made in the four sections of the questionnaire. For example, the topic electricity, is indicated by a total of 72 pupils as of the first or second or third choice in interest. A comparison with the same topic in Table VIII shows that 44 pupils listed or designated

Table VII. Summary Table Showing the Combined Results of Table II, Table IV, Table V, and Table VI.

Topic	Section I Interest	Section II Difficulty	Section III Usefulness	Section IV Would Like to Study
	(2)	(3)	(4)	(5)
Animals.....	5	2	1	14
Astronomy...	18	16	3	7
Atmosphere..	0	5	0	3
Aviation....	1	0	0	6
Bacteria....	15	2	7	6
Biology.....	4	2	2	8
Chemistry...	13	7	4	10
Disease.....	35	6	23	8
Electricity.	72	69	42	7
General dis-				
cussion....	1	0	1	1
Geology.....	0	0	0	3
Great scien-				
tists.....	0	3	0	1
Heat.....	9	8	7	1
Human body..	36	7	19	24
Light.....	4	2	1	2
Machines....	4	6	0	1
Magnetism...	1	1	1	0
Matter-				
energy.....	8	12	4	1
Nutrition...	22	18	15	2
Plants.....	27	11	27	5
Psychology..	0	0	0	3
Radio.....	0	0	0	5
Sound.....	3	2	0	1
Water supply	1	0	0	0
Weather.....	71	36	33	3

all the responses made in the four sections of the question-
naire. For example, the topic electricity, is indicated by
a total of 72 pupils as of the first or second or third
choice in interest. A comparison with the same topic in
Table VIII shows that 44 pupils listed or designated

Table VIII. Science Topics, Listed in Alphabetical Order, to Show the First Choices Made by High-School Sophomores in Each of the Four Areas of the Questionnaire.

Topic	Section I Interest	Section II Difficulty	Section III Usefulness	Section IV Would Like to Study
(1)	(2)	(3)	(4)	(5)
Animals.....	3	0	0	10
Astronomy...	4	6	2	5
Atmosphere..	0	2	0	1
Aviation....	1	0	1	3
Bacteria....	8	1	4	3
Biology.....	0	1	1	3
Chemistry...	4	3	2	6
Disease.....	16	3	13	4
Electricity.	44	56	25	2
General discussion....	0	0	1	0
Geology.....	0	0	0	2
Great scientists.....	0	0	0	2
Heat.....	2	2	2	1
Human body..	12	3	11	14
Light.....	0	0	0	1
Machines....	1	1	0	1
Magnetism...	0	0	0	0
Matter-energy.....	1	2	0	0
Nutrition...	3	4	5	0
Plants.....	10	8	10	3
Psychology..	0	0	0	2
Radio.....	0	0	0	5
Sound.....	2	0	0	1
Water supply	0	0	0	0
Weather.....	20	15	18	2

electricity as their first choice in interest. Table VII shows that 350 (total column 2) indicated interest in twenty of the twenty-five mentioned topics where the first three choices were included, but where only the first choices were

Table VIII. Science Topics, Listed in Alphabetical Order, to Show the First Choices Made by High-School Sophomores in Each of the Four Areas of the Questionnaire.

Topic	Section I Interest	Section II Difficulty	Section III Usefulness	Section IV Would Like to Study
(1)	(2)	(3)	(4)	(5)
Animals.....	3	0	0	10
Astronomy...	4	6	2	5
Atmosphere..	0	2	0	1
Aviation....	1	0	1	3
Bacteria....	8	1	4	3
Biology.....	0	1	1	2
Chemistry...	4	3	2	6
Diseases.....	16	3	13	4
Electricity.	44	56	26	2
General discussion....	0	0	1	0
Geology.....	0	0	0	2
Great scientists.....	0	0	0	2
Heat.....	2	2	2	1
Human body..	12	3	11	14
Light.....	0	0	0	1
Machines....	1	1	0	1
Magnetism...	0	0	0	0
Matter-energy.....	1	2	0	0
Nutrition...	3	4	3	0
Plants.....	10	8	10	3
Psychology..	0	0	0	2
Radio.....	0	0	0	3
Sound.....	2	0	0	1
Water supply	0	0	0	0
Weather.....	20	13	18	2

electricity as their first choice in interest. Table VII shows that 356 (total column 2) indicated interest in twenty of the twenty-five mentioned topics where the first three choices were included, but where only the first choices were

considered there were only 133 indications of interest and in only fifteen of the twenty-five topics.

The above-mentioned evidence has a specific meaning and value to the writer who is also a teacher of science as well as one who is seeking justification for proposing certain changes in the present arrangements in his school. Assuming the validity of the first choices of pupils, then the course could be built around a shorter list of topics. This would imply a number of other considerations such as reducing the amount of equipment and materials needed, decreasing the amount of time in the school schedule for general science, or perhaps planning for greater emphasis on the smaller number of topics.

However, if we assume that it is more valid to accept the data of Table VII which covers four interest areas of each pupil we must reconsider and revise our conclusions. To the writer it would appear that this table is the one which offers the more valuable data. In the light of our knowledge of children in regard to their attention span and instability of interests, the longer list of interests would form the basis for a program of general science which more completely meets the needs and interests of them. A course in general science cooperatively planned by pupil and teacher would tend to impinge on the primary and secondary interests of the group. At the junior-high-school age a number of topical

areas studied for shorter periods of time, rather than fewer topics studied for long periods would serve to increase the general interest as well as maintain it. The writer does not imply here that a number of short topics should be the science sequence but rather that the units of work would be comprehensive enough to include those topics which offer variety but at the same time contribute to the meaning and value of the unit. Such units could be constructed along the lines of the unit assignment as advocated by Billett.[1]

> Morover, the unit assignment (planned after the unit has been stated and delimited) must be flexible enough to provide for all significant differences among the pupils. In such an assignment different pupils may begin at different places and proceed at different rates in different sequences. Pupils are expected to differ in final achievement, industry, aptitudes, aims, and hence in needs.
>
> The unit assignment....is the general plan of teacher-pupil activity. In other words, it is the best sequence of teacher-pupil activity which the teacher was able to arrange prior to the opening of the teacher-learning cycle.

Information furnished by parents.-- The parents furnished some data in response to a request for their suggestions which might be pertinent to any reorganization of the science program. It was interesting to note that their suggestions could be classified into the same categories or topical areas as those of the children and of the

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[1] Roy O. Billett, Fundamentals of Secondary-School Teaching, Houghton Mifflin Company, Boston, 1940, p. 506.

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[1] Roy O. Billett, Fundamentals of Secondary-School Teaching. Houghton Mifflin Company, Boston, 1940, p. 306.

textbooks. The data are assembled in Table IX below. Forty-seven homes responded to a letter sent home via the pupils.

Table IX. Topics Which Parents of Junior-High Pupils Would Like Their Children to Study in Junior-High-School General Science.

Topic	Mother's Suggestions	Father's Suggestions	Totals Mother and Father
(1)	(2)	(3)	(4)
Animals.....	5	1	6
Astronomy.....	3	2	5
Atmosphere.....	1	0	1
Aviation.....	0	1	1
Bacteria.....	0	3	3
Biology.....	4	2	6
Chemistry.....	7	7	14
Disease.....	1	0	1
Electricity.....	10	17	27
General discussion.....	3	3	6
Geology.....	2	3	5
Heat.....	4	5	9
Human body.....	3	4	7
Light.....	0	4	4
Machines.....	3	11	14
Magnetism.....	2	4	6
Matter-energy...	0	6	6
Nutrition.....	5	3	8
Plants.....	7	4	11
Psychology.....	1	1	2
Radio.....	3	4	7
Sound.....	0	1	1
Water supply....	1	2	3
Weather.....	1	2	3
Totals of Suggestions...	66	90	156

textbooks. The data are assembled in Table IX below. Forty-seven homes responded to a letter sent home via the pupils.

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Topic	Mother's Suggestions	Father's Suggestions	Totals Mother and Father
(1)	(2)	(3)	(4)
Animals.....	5	1	6
Astronomy.....	3	2	5
Atmosphere.....	1	0	1
Aviation.....	0	1	1
Bacteria.....	0	3	3
Biology.....	4	2	6
Chemistry.....	7	7	14
Disease.....	1	0	1
Electricity.....	10	17	27
General discussion.....	3	3	6
Geology.....	2	3	5
Heat.....	4	5	9
Human body.....	3	4	7
Light.....	0	4	4
Machines.....	3	11	14
Magnetism.....	2	4	6
Matter-energy...	0	6	6
Nutrition.....	5	3	8
Plants.....	7	4	11
Psychology.....	1	1	2
Radio.....	3	4	7
Sound.....	0	1	1
Water supply....	1	2	3
Weather.....	1	2	3
Totals of Suggestions...	66	90	156

A copy of this letter may be found in the Appendix, page 51. It will be noted that 66 suggestions were made by mothers and 90 were offered by fathers. Does this indicate that science is more of a man's subject than a woman's? It will also be noted that the suggestions tend to reflect the science courses which they had probably studied during their school experiences.

The topic, electricity, is the most frequently mentioned one in the list. This was also true of the response made by pupils as is shown in Table II. Chemistry and machines tie for second place while plants are mentioned with the third highest frequency. Another observation of interest is that those topics which usually appear in a general-science course, atmosphere, disease, and even water-supply rate much lower down. One rather surprising situation is the fact that the topic, aviation, is mentioned only once by a parent. The place that aviation holds in our present-day living would lead one to expect a far greater interest in it as well as need for it.

A copy of this letter may be found in the Appendix, page 81.

It will be noted that 86 suggestions were made by mothers and 80 were offered by fathers. Does this indicate that science is more of a man's subject than a woman's? It will also be noted that the suggestions tend to reflect the science courses which they had probably studied during their school experiences.

The topic, electricity, is the most frequently mentioned one in the list. This was also true of the responses made by pupils as is shown in Table II. Chemistry and machines tie for second place while plants are mentioned with the third highest frequency. Another observation of interest is that those topics which usually appear in a general-science course, atmosphere, disease, and even water-supply rate much lower down. One rather surprising situation is the fact that the topic, aviation, is mentioned only once by a parent. The place that aviation holds in our present-day living would lead one to expect a far greater interest in it as well as need for it.

CHAPTER III

CONCLUSIONS AND RECOMMENDATIONS

General science and the total school program.-- General science is only a part of the total school experience of a child. At the same time, it is an important part. It is important because of the unique contributions it can make in the general education program which concerns the child. It is also important in that it can provide data which will or can be of great help in the guidance of the youngster. There are many general and specific objectives written for the general-science courses offered in our public schools. The writer, however, is at the moment most concerned with a certain few which are given here.

1. To help the child to determine for himself his aptitudes and limitations in the field of science to the extent that this is possible in junior high school.
2. To help him determine and evaluate his reaction to the area of science in terms of the pleasure he may derive from it.
3. To assist him to understand the value to the human race of the science that he studies and its effect on the way he lives.

4. To get pleasure from his study of general science so that it may develop his interest to the extent that it will lead him to look for vocational guidance in the field and perhaps give him the basis for leisure time activities in the form of related hobbies.
5. To find his science knowledge of some immediate usefulness in becoming a better consumer and in general helping him to make intelligent decisions.

Many other statements of objectives could be made which apply to the teaching of general science, but these which have just been mentioned will suffice for the writer's purposes. These specific statements, plus those which they imply, require that the science experiences which we would have our pupils enjoy, be well planned.

Many areas and topics should be explored.-- Boys and girls of junior-high-school age are interested in many things. This is shown in Table I, pages 14-15, which shows the interest placement of various general-science topics. This range of interests indicates that the development of a science curriculum should be influenced by them. Provision must be made for a large number of varied science experiences. These need not be provided for at the same instant. In fact, it is doubtful whether a teacher could make the necessary provisions for each pupil to work on a different topic

efficiently and successfully. The implication is, however, that at some time during his junior-high-school life the pupil will have an opportunity to investigate several topical areas which seem to have especial significance to him. The capable teacher can do much to simplify the task by use of proper motivation and by making provisions for individual differences and yet have the entire group attacking the same topical area. A particular pupil should be allowed and even encouraged to work on a phase of the group problem which seems to have real and immediate value to him.

The very nature of science, however, should also require of each pupil certain common understandings which are basic to scientific knowledge and attitudes. For example, a knowledge of the nature of substance is basic to the development of a scientific concept of the relation of nutrition to body growth and maintenance. This is also a requirement for practically all other scientific knowledge and understanding. By giving the pupil opportunities for the development of basic concepts in relation to many topics he gradually assumes an intelligent viewpoint toward his environment. This viewpoint will be one which is based on scientific facts with which he has become acquainted. Superstition and imagination will play an ever-decreasing role.

The data of Table I indicate that in this representative group of pupils, interest is present in some degree in each

of the listed topics. From this it can be concluded that the reading materials now used in general science may still be used. It would be very helpful to add to them a multitude of related materials which would give added opportunities for broader approaches to the same topics. These materials should be chosen with the reading abilities of the pupils in mind. Much of the literature should be well illustrated by means of good photographs and well-explained diagrams. The range of interests shown in the table also suggests that some materials were advanced in presentation and should be included for the pupil of exceptional interests and ability. It is, of course, equally necessary to provide materials as elementary in approach as is required to meet the abilities and capacities of the least qualified child. If such a range of materials is provided, no pupil will be without resources commensurate with his abilities. This will result in some degree of successful participation by each pupil of the group.

Difficult topics should not be eliminated.-- It was not too long ago that many people concerned with the education of young people thought that only difficult material was worth presenting in school. Subject matter which was learned with difficulty was thought to have certain disciplinary values. We have since learned that this is not so, at least in all cases. On the other hand, this does not imply that we should go to the other extreme and omit the study of topics and

areas which are learned with some degree of difficulty. The data of Table IV, page 21, show that interest may run high in certain topical areas which pupils themselves have indicated are difficult to master. The important factor here, then, is the interest. If no interest is present or if none can be generated in a pupil relative to a certain topic, it may be well to omit that topic. This, however, presents a problem, particularly if the topic is considered an essential one to later success in science. It would seem to the writer that this resolves itself into a problem which may be partially resolved into one of presentation and motivation and development. The writer would therefore suggest that before an area be omitted because of apparent difficulty, due consideration be given to the problem of presentation. It would be well to consider such questions as the following.

1. What makes the work difficult for pupils?
2. Is it appropriate to the age level and ability of the group?
3. Is it logically placed in the course sequence?
4. Is there a sufficient amount of materials available for the study of the topic?
5. Are suitable materials available for the individuals concerned?
6. Does the child feel that the unit is necessary?

Organization of the general-science program is important.-- In the Forty-sixth Yearbook of the National Society for the Study of Education, Part I,[1] are found several references to the organization of science in the junior high school.

> Science is universal and constant in the life of our citizens, and hence to be useful to all pupils, general science must accept the science of common things as its legitimate field. The science of common use and that of the classroom should be the same. General science should use any phases of any special science which is pertinent in the citizen's interpretation of a worth-while problem....In organizing this material, the topic should be the large unit to which many specific pieces of work are related.
>
> ....In many junior high schools general science is taught in but one or two of the three years; in others it is taught in all three years. In some junior high schools science is taught for two or three periods each week during the seventh and eighth school years and for five periods during the ninth year....Obviously this confused situation calls for further study and experimentation. Such sequences of science subjects as those recommended by the Thirty-first Yearbook appear to have but partial approval in actual school practices. As often remarked it is still much easier to see what seems good to do than it is to do those things.

The data obtained relative to whether pupils like or dislike science seem particularly pertinent to the problem. These data are presented in Table III, page 19. It will be recalled that in the writer's school general science is required in each of the three junior-high-school grades. The greatest amount of time is spent on ninth-grade science.

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[1] National Society for the Study of Education, Forty-sixth Yearbook, Part I, University of Chicago Press, 1947, p.154.

Organization of the general-science program is important.-- In the Forty-sixth Yearbook of the National Society for the Study of Education, Part I, [1] are found several references to the organization of science in the junior high school.

From the data obtained, however, we can see that interest is greatest in the seventh grade and least in the ninth. It is contrary to the philosophy of modern education to maintain a situation like this. It would seem that the only alternative is to rearrange the general-science schedule and the following recommendations are made:

1. General science should be required for the equivalent of four class periods a week in the seventh grade for the entire school year. This would be taking advantage of the indicated high interest of seventh-graders with a probable increase in efficiency and effectiveness of instruction.
2. General science should be required for a minimum of two periods a week, preferably three, in grade eight. By so arranging the eighth-grade schedule we would be recognizing the diminishing interest of the student body, but at the same time making a science course available to those who wish to maintain continuity in the subject.
3. Finally, the writer in the light of the data obtained from the study of his own school system, questions the value of continuing the science courses on the same required basis as now exists. The situation is not a happy one and is in some respects, at least, a reflection on the presentation of our science

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3. Finally, the writer in the light of the data obtained from the study of his own school system, questions the value of continuing the science courses on the same required basis as now exists. The attitude is not a happy one and is in some respects, at least, a reflection on the presentation of our science

material and work. A new approach is needed to ninth-grade general science.

The fact that most ninth-graders do not consider ninth-grade general science of the same value as those who teach it, would suggest two solutions which should eventually lead to a full-fledged science program for the ninth grade. The first is that general science should be offered on an elective basis and the second is that there should be two approaches to the subject.

Pupils who are interested in science will elect ninth-grade general science. This will enable those who have a real interest in it to continue to the high-school stage. With the offering of two types of general science, the content of each course can be varied more effectively to meet the needs of those who elect the courses.

One course should be offered on the basis of four periods a week for the school year and should consist of content material which will adequately prepare for high school and college. Pupils who elect this course would, in most cases, be those who are preparing for college. Another science elective should be made available with the same time allotment for those who might terminate their education in the not too distant future or for those who are planning to attend a vocational school or enter into an apprenticeship in some trade. The content of this course would differ in

material and work. A new approach is needed to ninth-grade general science.

The fact that most ninth-graders do not consider ninth-grade general science of the same value as those who teach it, would suggest two solutions which should eventually lead to a full-fledged science program for the ninth grade. The first is that general science should be offered on an elective basis and the second is that there should be two approaches to the subject.

Pupils who are interested in science will elect ninth-grade general science. This will enable those who have a real interest in it to continue to the high-school stage. With the offering of two types of general science, the content of each course can be varied more effectively to meet the needs of those who elect the courses.

One course should be offered on the basis of four periods a week for the school year and should consist of content material which will adequately prepare for high school and college. Pupils who elect this course would, in most cases, be those who are preparing for college. Another science elective should be made available with the same time allotment for those who might terminate their education in the not too distant future or for those who are planning to attend a vocational school or enter into an apprenticeship in some trade. The content of this course would differ in

that it would probably stress the applications of science to everyday problems which the pupils would be apt to meet. The college preparatory group would also find the science a practical course but there would be in addition a greater stress on the fundamental concepts needed for later science study. Such courses should do much to help the individual become a resourceful person and help him to meet the problems he meets in his daily living.

A new approach to the ninth-grade science problem on the basis suggested above, if done well, should eventually find most of the ninth-grade people in one or the other science courses.

General-science learning products should be useful.--General-science learning products vary in usefulness to the learner. It is apparent that pupils do not consider general science too useful as is evidenced by the data of Table V, page 23. These data are considered very significant by the writer. Here is a situation which clearly shows those in the science field, if the writer's school can be called typical, have not been concerned with the usefulness of that which is taught. Of the twenty-two topics listed, only four of them are indicated by pupils as being of some degree useful to them. Another significant fact is that very few of the pupils found even these topics useful.

Somehow this must be considered and in some way

that it would probably stress the applications of science to everyday problems which the pupils would be apt to meet. The college preparatory group would also find the science a practical course but there would be in addition a greater stress on the fundamental concepts needed for later science study. Such courses should do much to help the individual become a resourceful person and help him to meet the problems he meets in his daily living.

A new approach to the ninth-grade science problem on the basis suggested above, if done well, should eventually find most of the ninth-grade people in one or the other science courses.

General-science learning products should be useful.--General-science learning products vary in usefulness to the learner. It is apparent that pupils do not consider general science too useful as is evidenced by the data of Table V, page 25. These data are considered very significant by the writer. Here is a situation which clearly shows those in the science field, if the writer's school can be called typical, have not been concerned with the usefulness of that which is taught. Of the twenty-two topics listed, only four of them are indicated by pupils as being of some degree useful to them. Another significant fact is that very few of the pupils found even these topics useful.

Somehow this must be considered and in some way

counteract and reverse this outcome. How it can be done to the greatest degree will require much experimentation and time. It is obvious, however, that this has failed to be done in more ways than one.

The interests of pupils, as indicated by the data obtained, can be considered one key or avenue to explore. More needs to be known about the make-up of these interests for through them it may be possible to help the child acquire a sense of usefulness about them. The degree of interest should be heightened by the way the teacher presents and helps the child develop the problems posed by the units of work. The relationship which the content has to the progress of man and the direct or indirect relationship it has to the individual pupil must be stressed. That material which cannot be so presented should be limited or omitted for nothing is gained by the memorization of facts, scientific or other. Time must be spent to help the pupil become aware of the functional aspects of that which he is studying.

It will be well to consider the oft-expressed viewpoint of education that teaching youth should be in terms of the future and for long-range values. The pupil, however, lives in the present. Now is the time of significance for him and teachers need to recognize this all-important fact. This does not imply that the future and the past be given no consideration. Teachers should be aware of the past in its

relationship to the present and its implications for the future. These same implications must be taught, by every method at command, so that the pupils understand them and experience them. Thus, little by little, our pupils will be helped to know what they are and what they are to become is decided in large measure by what has transpired in the past, and that their future is dependent upon the things they do and learn today.

The content material of textbooks and particularly our teaching should be so presented that pupils will willingly explore for themselves the usefulness of that which is studied. This can be done in part by helping them to see valid and direct connections between what they study and the way they live.

What pupils would like to study compared to what they are now studying in general science.-- There are at least two conclusions to be drawn from the data of Table VI, page 24. The range of topics as covered in our present three-year program or in the topics offered by the several general-science textbooks gives complete coverage of the items which pupils say they would like to have studied. The data also indicate that for one reason or another pupils do not recall what they have studied.

No part of the results obtained by asking pupils what they would like to have studied indicates any topic for

relationship to the present and its implications for the future. These same implications must be taught, by every method at command, so that the pupils understand them and experience them. Thus, little by little, our pupils will be helped to know what they are and what they are to become is decided in large measure by what has transpired in the past, and that their future is dependent upon the things they do and learn today.

The content material of textbooks and particularly our teaching should be so presented that pupils will willingly explore for themselves the usefulness of that which is studied. This can be done in part by helping them to see valid and direct connections between what they study and the way they live.

What pupils would like to study compared to what they are now studying in general science.-- There are at least two conclusions to be drawn from the data of Table VI, page 84. The range of topics as covered in our present three-year program or in the topics offered by the several general-science textbooks gives complete coverage of the items which pupils say they would like to have studied. The data also indicate that for one reason or another pupils do not recall what they have studied.

No part of the results obtained by asking pupils what they would like to have studied indicates any topic for

which some provision has not or cannot be made in our present science sequence. It may be of some significance to note that a few topics were so indicated such as animals, aviation, or human body. These same pupils had previously studied these areas. The writer would accept this as a challenge in two possible ways. Either these topics have not been taught effectively or the pupils have not been alerted to the point where they were able to recall that they had studied them.

The results, then, would indicate that the content material of our science courses is complete enough, but that our educational procedures must be studied carefully and work weighed critically against the objectives supposedly set for the work. This is saying again that those factors mentioned before must be considered: the relationships between the pupils on the one hand to their interests, and the usefulness and difficulty of the content on the other.

Parent statements do not offer many suggestions.-- It would seem that the general-science curriculum of the writer's school tends to meet the needs expressed by the parents for science content. The areas mentioned by the largest number of parents are electricity, chemistry, machines, and plants. The first three mentioned would tend to reflect the needs of people for understandings of their technological environment. The need for an understanding of this scientific age is or should be apparent to teachers. That it is necessary

to people in adult life is confirmed by the responses of parents. The data obtained by responses to the writer's letter to parents are found in Table IX, page 30.

This, then, is another indication that science teachers should be vitally concerned with making their teaching as functional as possible. If they are successful in this, pupils will not be content to merely accept the advantages of modern living but will, through understanding, be better able to use them efficiently and well.

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APPENDIX

CHECK LIST PRESENTED TO SEVENTH-, EIGHTH-, AND NINTH-GRADERS

My name is _____ I am _____ years old.

I go to the _____ Junior High School.

Dear Pupils:

Are you willing to help us build a general-science program which will be better than any we have ever had? If you are, will you please furnish the information which is asked for below? Please do it in exactly the way YOU really feel about it.

Sincerely yours,

Clifford R. Nelson

Directions: A list of topics which are generally studied in general science is printed below. Will you read the list carefully? After you have studied the list, place an X in the space after the number of the topic you would like to study. For example, if you would like to study about PLANTS you will place the X in the space after 1, like this.

1 ..X. Plants (including trees, flowers,and leaves)

1 .... Plants (including trees, flowers, and leaves)

2 .... Animals (birds, fish, mammals, insects)

3 .... Human body and health (structure, sleep, foods)

4 .... Earth science (rocks, soil, minerals)

5 .... Early animals (fossils, dinosaurs, etc.)

6 .... Atmosphere (where air is found, how man uses it)

7 .... Water (what it is, how man uses it)

8 .... Fire (what it is, what causes it, how man uses it)

9 .... Electricity (motors, bells, lights, wiring, etc.)

10.... Airplanes (how and why they fly)

11.... Engines (steam, gasoline, diesel, jet, and rocket)

12.... Chemistry (acids, soaps, paints, etc.)

13.... Medicine (drugs, disease, germs, and bacteria)

14.... Sound (noises, musical instruments, voice)

15.... Molecules and atoms (what everything is made of)

16.... Changing substances (by heating, cooling, mixing, etc.)

17.... Weather (causes, forecasting, flying, kinds)

18.... Machines (wheels, pulleys, crowbars, wheelbarrows)

19.... Transportation (science of autos, trains, ships, etc.)

20.... Communications (telephones, radio, radar, television)

21.... Light (causes, kinds, colors, dyes, use)

22.... Conservation (fire prevention, forests, rivers, soil)

23.... Astronomy (sun, stars, planets, shooting stars, telescopes)

24.... Biography (great scientists of past and present)

25.... Science (how the scientist does his work)

26.... If there is some other topic you would like to study which is not mentioned here in this list you may write it on the line below.

_____

Part II

We want to know if you like the study of general science. Please make the sentence below read so that it tells us how you feel about your study of science. Do it by crossing out either the do or do not. ALSO, tell us WHY by completing the sentence.

I (do) (do not) like to study general science because _____

_____

_____

You may write more about the way you feel and think about general science in the space below if you wish to.

DIRECTIONS TO TEACHER DIRECTING QUESTIONNAIRE

To the teacher directing the science questionnaire:

This questionnaire is part of an attempt to gather data which will help us to set up a general-science course which will meet the needs of junior-high-school pupils.

It will be appreciated if you will do the following:

1. Please have the pupils supply the requested information, after reading the letter.
2. Encourage them to answer freely and in accordance with their own viewpoints and experiences.
3. Help pupils where they are uncertain as to what they are expected to do.
4. Please collect papers and send them to the main office.

Thank you very much for your cooperation; it is greatly appreciated.

Sincerely,

Clifford R. Nelson

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To the teacher directing the science questionnaire:

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2. Encourage them to answer freely and in accordance with their own viewpoints and experiences.

3. Help pupils where they are uncertain as to what they are expected to do.

4. Please collect papers and send them to the main office.

Thank you very much for your cooperation; it is greatly appreciated.

Sincerely,

Clifford R. Nelson

LETTER TO SOPHOMORE FILLING IN

QUESTIONNAIRE

_____, Massachusetts
April, 1947

Dear _____ Sophomore:

You have been selected to help us in trying to solve an important problem concerning the junior-high-school general-science course. This problem is, "How can junior-high-school science be improved for the benefit of the student?"

As a sophomore, you are in an excellent position to answer certain questions which pertain to the science you studied while in the junior high school. These questions deal with such things as the interest science aroused in you, its usefulness to you, the difficulties you may have had, and whether it included all of the topics you would have liked to study.

On the paper which accompanies this letter are four questions dealing with the above-mentioned areas. Please read the directions carefully and then answer them to the best of your ability in the spaces provided.

We appreciate your willingness to do this, and we know that your cooperation will assist us in making general science of real value to the boys and girls of the junior high school.

Sincerely yours,

Clifford R. Nelson

Approved by:

LETTER TO SOPHOMORE FILLING IN QUESTIONNAIRE

_____, Massachusetts
April, 1947

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We appreciate your willingness to do this, and we know that your cooperation will assist us in making general science of real value to the boys and girls of the junior high school.

Sincerely yours,

Clifford H. Nelson

Approved by:

QUESTIONNAIRE PRESENTED TO SOPHOMORES

Write your name here_____Years old_____

I am a boy_____ girl_____ (check one)

Note: In the following directions the word "topic" is used to mean a unit or area of work in general science such as weather, electricity, nutrition, and so forth.

1. In each of the following spaces write the name of a topic which you found to be very interesting in junior-high-school science. The first topic should be the one you found most interesting.

   A. _____

   B. _____

   C. _____

2. Of all the topics in junior-high-school science which ones did you find difficult to understand? Write the three most difficult topics in the order of difficulty in the following spaces.

   A. _____

   B. _____

   C. _____

3. If any of the general-science topics which you studied were useful to you then, or have been since, please list them below in the order of usefulness.

   A. _____

   B. _____

   C. _____

4. If the general science you had in junior high school did not cover all the topics you wanted to study, please list three such topics below by completing the sentences which are started.

   A. I would like to have studied _____

   _____

   B. I would like to have studied _____

   _____

   C. I would like to have studied _____

QUESTIONNAIRE PRESENTED TO SOPHOMORES

Write your name here_____Years old_____

I am a boy_____ girl_____ (check one)

Note: In the following directions the word "topic" is used to mean a unit or area of work in general science such as weather, electricity, nutrition, and so forth.

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C. I would like to have studied _____

LETTER SENT HOME TO PARENTS REQUESTING THEIR SUGGESTIONS

Dear Parents:

I am sending this note to you by courtesy of your child who is one of my science pupils. It is for your suggestions which will help us make our general-science classes more valuable to your children.

In the light of your practical experiences, will you kindly indicate those areas of study, in the field of junior-high-school science, from which you have or could have benefited.

I am interested in getting both the woman's and the man's point of view and have therefore provided a space for each of you to use. If the spaces provided below are not enough, please use the back of the paper.

Thank you for your cooperation.

Sincerely yours,

MOTHER FATHER

Boston University
School of Education
Library

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